MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2016/2017

EEN1016 – ELECTRONICS I

(All sections / Groups)

17 OCTOBER 2016
9.00 am- 11.00 am
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 5 pages with 4 Questions only excluding cover page.
2. Attempt **ALL FOUR** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.

Question 1

[A]

(i) Why the energy gap of intrinsic Si-semiconductor decreases monotonically with temperature? Explain briefly and clearly.

[2Marks]

(ii) A pure Si-crystal is doped with $1x10^{16}$ Arsenic atoms/cm^3. A student has reported following observations at thermal equilibrium (assuming complete ionization), $n_0=1x10^{17}/cm^3$ and $p_0=1x10^5/cm^3$.

(a)Is the reported observation correct? Explain in brief with proper reason.

[3Marks]

(b) Draw the band diagram of resulting extrinsic Si-semiconductor. Show clearly the Fermi level and impurity level also.

[4Marks]

(iii) Consider a Silicon semiconductor material at T=300K in which Fermi-level is 0.25eV above the valence band edge. Is this material n-type or p-type? Explain with justification. Also determine what impurity material should be added to get this semiconductor?

[3Marks]

[B]

(i) Consider a Si-semiconductor material in which two charge carriers are; A and B. The required parameters for these two carriers are;

A: mean free time between scattering=$2x10^{-13}$ sec and effective mass= 0.26 m_0.

B: mean free time between scattering=$1x10^{-13}$sec and effective mass=0.36 m_0.

Determine the mobility of these two carriers and also identify these two carriers. Give proper reason for your answer.

[3+1Marks]

(ii) Calculate the diffusion current density in n-type Si-semiconductor material at room temperature where electron concentration varies linearly from $1x10^{18}/cm^3$ to $7x10^{17}/cm^3$ over a distance of 0.1cm. Assume $D_n=22.5$ cm^3/sec.

[3Marks]

(iii) Minority carrier holes are injected into homogeneous n-type semiconductor sample at one point. An electric field of 50V/cm is applied across the sample and the carriers move 1cm in 100 μs in the presence of field. Find the diffusivity of the minority carriers.

[6Marks]

Continued .....

Question 2

[A]For a Silicon p-n junction, doping concentration in both regions is; $N_a=10^{19}/cm^3$ and $N_d=10^{16}/cm^3$ at room temperature. Calculate

(i) Built-in potential (V_{bi}).

(ii) Depletion region width

(iii)The maximum electric field,

(iv)Explain clearly why in absence of bias no current flows in the p-n junction.

[2+4+3+2 Marks]

[B]

(i) Figure Q2[B] shows the I-V characteristics of real and ideal diode. Identify the type of diode based on the characteristics and give proper explanation in support of your answer.

[4Marks]

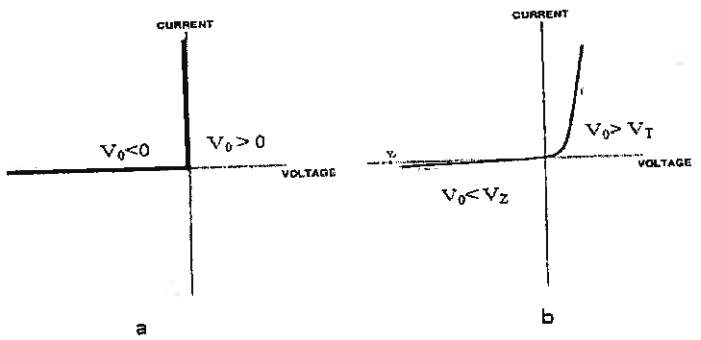

Figure Q2[B]

(ii) Explain qualitatively, why forward bias current increases rapidly with applied forward bias voltage?

[2Marks]

[C] For the circuit shown in Figure Q2[C], plot V_o under steady state conditions, with and without capacitor C. Assume that the diode is ideal.

[4Marks]

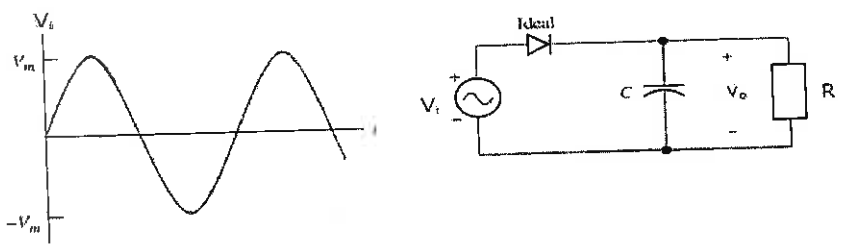

Figure Q2[C]

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Question 2

[D] Sketch the output waveform of the circuit as shown in Figure Q2[D]. Assume diodes are ideal. Assume $v_i(t)=15\sin\omega t$.

[4 Marks]

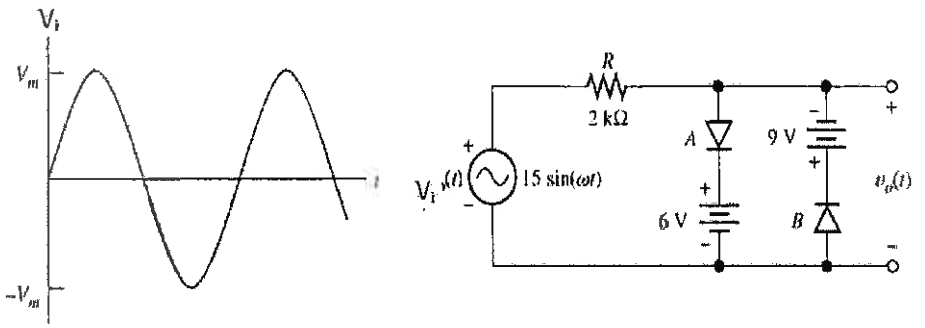

Figure Q2[D]

Important Parametrs

E_g(silicon) at T=300K= 1.12eV,
$m_0=9.1\times10^{-31}$Kg,
KT(at T=300K)=26meV,
$q=1.6\times10^{-19}$C,
Permittivity of vacuum, ε_0= 8.845×10-14 F cm-1
Relative permittivity of silicon $\varepsilon_{si}/\varepsilon_0$= 11.8
$n_i=1.5\times10^{10}/cm^3$ for Silicon at T=300K

Continued .....

Question3

[A] Describe in brief the bias configuration of a bipolar junction transistor (BJT) in active, cutoff and saturation region. Name one application of BJT in active region.

[7 marks]

[B] A BJT circuit is shown in Figure Q3[B]. Identify if this circuit is common emitter, common base or common collector configuration with your justification.

[4 marks]

[C] Given that R_E =5kΩ, R_B = 50kΩ, R_C = 5kΩ and $V_{EB(on)}$ = 0.7V in Figure Q3[B]. If emitter voltage, V_E is measured as 1.2V, find the base voltage V_B, collector voltage V_C, base current I_B, collector current I_C, emitter current I_E, beta β and alpha, α.

[14 marks]

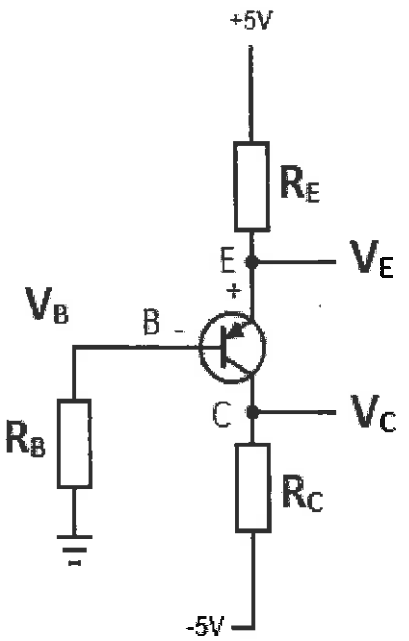

Figure Q3[B]

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Question 4

A common emitter (CE) amplifier circuit is shown in Figure Q4. Given that R_S = 2.5kΩ, R_1 = 40kΩ, R_2 = 5.7kΩ, V_{CC} = 10V, R_C = 5kΩ, R_E = 0.5kΩ and R_L = 10kΩ. Assume V_T at room temperature is 25mV, $V_{BE(on)}$ = 0.7V and β = 100.

(i) Find the DC collector current, I_C. Prove that the BJT is operating in active region. [6 marks]

(ii) Sketch the small signal equivalent circuit using the hybrid π model of BJT. [3 marks]

(iii)Calculate the small signal parameters g_m and r_π. [4 marks]

(iv)Determine the r_0 when early voltage, V_A is given 100V. [2 marks]

(v)Calculate the R_{in} and R_{out}. [4 marks]

(vi)Determine the small signal voltage gain, V_o/V_s. [6 marks]

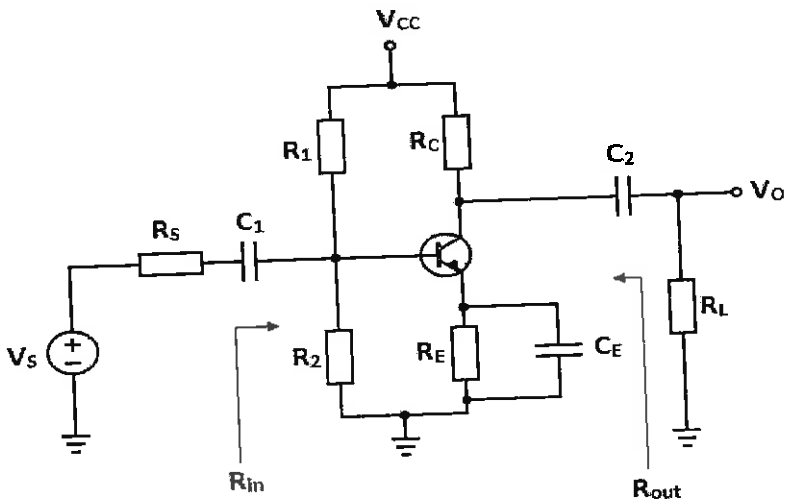

Figure Q4

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